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# **Social Inequalities in Adult Oral Health in 40 Low and Middle Income Countries**

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## **ABSTRACT**

**Objective:** This study evaluated social inequalities in adult oral health across several low and middle income countries.

**Methods:** We used data from 40 countries that participated in the World Health Surveys. Participants' socioeconomic position was assessed using the wealth index. Oral health was assessed using two perceived measures, namely total tooth loss and whether they had any problems with their mouth and/or teeth during the last 12 months (perceived needs). Absolute and relative wealth inequalities in oral health were measured using the slope index of inequality (SII) and relative index of inequality (RII), respectively, adjusting for participants' sex, age and education.

**Results:** There were wealth inequalities in total tooth loss and perceived needs in most countries. However, significant monotonic gradients were found in 21 countries for total tooth loss and 18 countries for perceived needs. Two distinctive patterns of social inequality in oral health were found across countries using the RII and SII. For total tooth loss, pro-rich inequality was found in 25 countries (significant RII/SII in 8 countries) while pro-poor inequality was found in 15 (significant RII/SII in 3 countries). For perceived needs, pro-poor inequality was found in 26 countries (significant RII/SII in 6 countries) while pro-rich inequality was found in 14 (significant RII/SII in 5 countries).

**Conclusions:** The well-documented social gradient in adult oral health favouring the rich was not present in all low and middle income countries. Pro-poor inequalities in total tooth loss, and particularly in perceived dental treatment needs, were observed in some countries.

## INTRODUCTION

There is overwhelming evidence on socioeconomic inequalities in adult oral health. Oral diseases are disproportionately represented in adults of low socioeconomic position (SEP). However, poor oral health is not limited to the lower end of the social scale, but there is a social gradient in oral health determined by individuals' position in the social ladder<sup>1,2</sup>. Most evidence on social inequalities in adult oral health comes from developed countries<sup>3-6</sup>. A robust association between SEP and adult oral health has been found regardless of what SEP indicator is used, which oral health outcome is assessed and whether all the population or only a segment (such as senior adults) is evaluated.

Recent literature has focused on monitoring social inequalities in adult oral health by assessment of trends within countries or comparisons between countries. Monitoring social inequalities in health is important to improve understanding of the social determinants of health and evaluate policies to promote health and reduce health inequalities<sup>7,8</sup>. Within countries, despite large declines in the prevalence and incidence of oral diseases at global, regional and country levels over the past two decades<sup>9-11</sup>, social inequalities in oral health persist and may be widening<sup>3-6</sup>. There is also evidence of variations in social gradients in oral health between countries, even among rich neighbouring countries like those in Europe<sup>3,5</sup> and North America<sup>4</sup>. Based on these combined findings, some have argued that social inequalities in adult oral health are universal<sup>1,2</sup>.

Despite the paucity of studies monitoring social inequalities in oral health in developing countries, a few national surveys in developing countries show contradicting evidence<sup>12-16</sup>. A significant social gradient in caries experience was found among Vietnamese adults aged 18 years or above<sup>12</sup>. Although a significant gradient in self-reported worse oral health status by household consumption was also found among 15-75-year-old Thai during bivariate analysis; this association was fully attenuated after controlling for socio-demographic factors<sup>13</sup>. On the other hand, education was not related to severe caries (defined for the study as having 16 or more decayed or missing teeth) among Pakistani adults aged 25 years or over<sup>14</sup>. Moreover, a significant interaction was found between the count of durable goods in the household and community development, such as in communities with low development it was the more advantaged who were more likely to have severe caries while in communities with a high level of development it was those with few foods who were most likely to have severe caries<sup>14</sup>. In Mexico, the prevalence of edentulism decreased with increasing household wealth in adults aged 35 years or above<sup>15</sup> whereas the opposite trend was found for the prevalence of self-reported oral/dental

problems in adults aged 18 years or above<sup>16</sup>. There is also evidence in medicine showing that the shape of the social gradient in health varies by economic development and the stage at which the country is in the demographic, epidemiologic and nutrition transitions<sup>17-19</sup>. Therefore, this study aimed to evaluate social inequalities in adult oral health across several low and middle income countries, using a comparable dataset and measurement method.

## **METHODS**

### **Data Source**

Data were obtained from the World Health Survey (WHS) conducted in 2002-2004, which was launched by the World Health Organization (WHO) to provide valid, reliable and comparable information across 70 countries from all world regions regarding health status and health systems. In each country, the target population was adults aged 18 years and over living in private households. Participants were selected using multistage stratified cluster sampling with the intention of collecting nationally representative samples. However, in six countries the survey was carried out in geographically limited regions and random sampling was not used. Sample size varied from 1000 to 10000 between countries whilst ensuring sample to be nationally representative of the population<sup>20</sup>.

Fifty of the 70 WHS countries were classified as low and middle income economies according to the 2003 World Bank's classification, and were initially selected for this analysis. We excluded the following countries: China, Comoros, Congo, India, Ivory Coast and the Russian Federation because samples were not nationally representative; Zambia and Guatemala because their data files have no survey information needed to produce nationally representative estimates; and Tunisia and Mauritania because their study samples (participants with complete data in relevant variables) represented 20.4% and 45.4% of the full sample of the participants, respectively.

### **Variables selection**

Participants' SEP was determined using the wealth index<sup>21,22</sup>, which classifies households based on their ownership of a range of permanent income indicators (household assets) ranging from bicycle, mobile phone, fixed line phones and refrigerator to computer, dish washer, washing machine and car. Country-specific items were also added to the list of assets to fit the standard of living of the countries, and the final list included between 11 and 20 items. A principal components analysis (PCA) was then done separately for each country to determine the weights to create an index of the asset variables.

The weights for the first component were then applied to each person's data giving a continuous asset index measure<sup>21</sup>. Because the PCA was done separately for each country, the absolute value of the wealth index cannot be compared between countries. We thus categorised this index into tertiles to improve cross-country comparability of social gradients.

Two perceived oral health indicators were the outcome variables. The first measured total tooth loss through the question 'have you lost all of your natural teeth?' and the second measured dental treatment needs through the question 'During the last 12 months, did you have any problems with your mouth and/or teeth?' Binary response options (no/yes) were used with the two items.

Covariates were participants' sex, age and education. Age was categorised as 18-29, 30-39, 40-49, 50-59, 60-69 and 70 years and above. Education was measured using a 7-point response scale and responses collapsed into three categories (primary school or less; secondary school; and college and higher education), to enhance cross-country comparability. For one country (Turkey), the categorical classification of education was missing and years of education were converted into three categories based on the Turkish Ministry of Education classification. Although education is a common SEP indicator in high-income countries, we treated it as a confounder because it reflects childhood SEP (it happened before the creation of wealth in adult life) more so in developing than in developed countries<sup>23</sup>. Furthermore, education has its own effects on health status, which may offset low economic status; but more education does not necessarily lead to greater wealth in low and middle income countries.

### **Statistical analysis**

STATA/IC 12 for Windows (Stata Corp., College Station, Texas, USA), using the *survey* command, was used for data analysis. All analyses took into account the complex survey design (stratification and clustering) as well as the sample weights to produce nationally representative estimates. Of the 214,240 respondents in the 40 countries, 28,458 (13.3%) had missing data on total tooth loss, 27,097 (12.6%) on problems with mouth and/or teeth, and 6,147 (2.9%) on one or more covariates. As there is ongoing debate on whether multiple imputation methods are useful with missing outcome data<sup>24,25</sup> (the two oral health measures explained the largest proportion of missing data), we opted for excluding participants with missing data from the analysis (casewise deletion).

We first presented the crude prevalence of total tooth loss and problems with mouth and/or teeth in the full sample of each country and then stratified by household wealth. Linear trends for the association of household wealth with each oral health outcome were assessed fitting the former as a continuous variable in survey logistic regression models. Results were presented for low, lower middle and upper middle income countries (LIC, LMIC and UMIC respectively).

The Slope Index of Inequality (SII) and Relative Index of Inequality (RII) were used to measure, respectively, the magnitude of absolute and relative inequalities in oral health by household wealth. These regression-based indicators take the whole socioeconomic distribution into account, rather than only comparing the two most extreme groups<sup>8,26</sup>. To that end, wealth tertiles were transformed into a summary measure (Ridit score) that was scaled from zero (first/bottom tertile) to one (third/top tertile) and weighted to reflect the share of the sample at each wealth tertile. Ridit scores reflect the average cumulative frequency of the group, a midpoint of the range in the cumulative distribution as described in detail elsewhere. For instance, if the first wealth group included 34% of the population, the range of participants in this category is from 0.00 to 0.34 and assigned a ridit score of 0.17 ( $=0.34/2$ ), if the second wealth group included 32% of the population from 0.34 to 0.66, the corresponding ridit score was 0.50 ( $=0.34 + 0.32/2$ ) and if the third wealth group included 34% of the population from 0.66 to 1.00, the corresponding Ridit score was 0.83 ( $=0.66 + 0.34/2$ ). Ridit scores were used in regression models, instead of the wealth tertiles, to estimate the SII and RII<sup>27</sup>.

Linear and logistic regressions were used to estimate SII and RII, respectively, in models adjusting for sex, age and education. SII and RII were calculated with 95% confidence intervals (CIs). The SII represents the absolute difference in total tooth loss and problems with mouth and/or teeth when moving from the bottom through the highest top wealth tertile. On the other hand, RII measures the odds of reporting total tooth loss or problems with mouth and/or teeth in the top tertile compared to the bottom tertile<sup>8,26</sup>. A SII value lower than zero (or a RII value lower than 1) indicates that the oral health outcome is more common among the worse-off whereas a SII value higher than zero (or a RII value higher than 1) indicates that the oral health outcome is more prevalent among the better-off<sup>8,26</sup>.

## RESULTS

We used data from 180,996 adults, aged 18 years and older, living in 40 low and middle income countries (17 LIC, 13 LMIC and 10 UMIC). The number of adults participating in the WHS in these

countries ranged from 929 in Latvia to 38,746 in Mexico whereas the analytical sample used for each country represented between 61.0% and 99.5% of all WHS participants. Those excluded because of missing data were significantly older, more educated and wealthier than those with complete data.

The prevalence of total tooth loss ranged from 1.1% in Kenya and Myanmar to 15.7% in Hungary (Table 1). There were wealth-related inequalities in total tooth loss in most countries. Significant monotonic gradients in total tooth loss by wealth tertiles were found in 21 of 40 countries and they were more common in more developed economies (35% of LIC, 46% of LMIC and 90% of UMIC). Two distinctive patterns were found based on the adjusted RII and SII (Table 2). For the majority of countries (9 LIC, 8 LMIC and 8 UMIC), the RII was lower than 1 (ranging from 0.13 for Swaziland to 0.94 for Paraguay) and the SII was lower than zero (ranging from -16.8% for Zimbabwe to -0.2% for Burkina Faso), suggesting that the prevalence of total tooth loss was higher in the bottom than the top wealth tertile. For the remaining countries (8 LIC, 5 LMIC and 2 UMIC), the RII was higher than 1 (ranging from 1.05 for Senegal to 7.08 for Vietnam) and the SII was higher than zero (ranging from 0.3% for Senegal to 12.8% for Namibia), suggesting that total tooth loss was more prevalent in the top than bottom tertile of wealth. However, the RII and SII were significant in 11 countries (3 LIC, 6 LMIC and 2 UMIC), with total tooth loss being more common among the worse-off in Lao, Zimbabwe, Bosnia and Herzegovina, Dominican Republic, Swaziland, Turkey, Latvia and Uruguay and among the better-off in Vietnam, Namibia and Philippines.

The prevalence of problems with mouth and/or teeth ranged from 12.8% in Myanmar to 63.7% in Kazakhstan (Table 3). There were inequalities in problems with mouth and/or teeth by household wealth in most countries. However, significant monotonic wealth gradients in problems with mouth and/or teeth were present in 18 of 40 countries and they were more common in less developed economies (47%, 46% and 40% for LIC, LMIC and UMIC respectively). The adjusted RII and SII showed two opposite patterns (Table 4). For 26 countries (8 LIC, 11 LMIC and 7 UMIC), the RII (ranging from 1.02 for Mauritius to 2.19 for Uruguay) and the SII (ranging from 0.4% for Mauritius to 16.7% for Slovakia) suggested that the prevalence of problems with mouth and/or teeth was higher in the top than bottom wealth tertile. For the second group of countries (9 LIC, 2 LMIC and 3 UMIC), the RII (ranging from 0.49 for Ethiopia to 0.92 for Latvia) and the SII (ranging from -10.6% for Malawi to -2.0% for Latvia) indicated that problems with mouth and/or teeth were more prevalent in the bottom than top wealth tertile. However, the adjusted RII and SII were only significant in 11 countries (7 LIC, 2 LMIC and 2 UMIC),



with problems with mouth and/or teeth being more prevalent among the worse-off in Ethiopia, Ghana, Malawi, Nepal and Philippines and more prevalent among the better-off in Kazakhstan, Lao, Pakistan, Dominican Republic, Mexico and Uruguay.

## **DISCUSSION**

Our results indicate that wealth-related inequalities in self-reported total tooth loss and perceived dental treatment needs (problems with mouth and/or teeth in the past year) were present in countries from different WHO regions and at different levels of national income. Significant gradients were found in 11 of 40 countries evaluated, with evidence of both pro-rich and pro-poor wealth inequalities in oral health (gradients in total tooth loss and treatment needs favouring the better-off and worse-off, respectively). These findings were not accounted for by participants' sex, age and education.

The present results should be interpreted bearing in mind some study limitations. First, data on total tooth loss and dental treatment needs were based on self-reports, which may raise concerns about their validity when compared to objective clinical assessments. However, self-reported measures are valid and reliable indicators of individuals' oral health status and positively correlated with disease measures<sup>28,29</sup>. Self-reported tooth counts can be used to estimate the number of remaining teeth accurately<sup>28,30</sup> whereas self-assessed needs are positively correlated with disease measures and valuable in assessing the needs of adults<sup>31,32</sup>. In addition, similar results were found in previous surveys conducted in some of these countries<sup>15,16</sup>, even when using clinical measures<sup>33</sup>. Second, we used the wealth index to measure participants' SEP. The wealth index is considered a stable and effective indicator for monitoring long-term SEP of individuals and their households in developing countries where education and occupation are often inaccurate and not likely to capture the full extent of an individual's SEP<sup>21,22</sup>. Household income and consumption expenditure are other alternatives but have their limitations compared to wealth<sup>21</sup>. In addition, the decision to use wealth tertiles was empirical, since quartiles and quintiles did not provide equal-size groups or enough participants for meaningful comparisons in some countries. Third, we used linear and logistic regression to estimate the SII and RII, respectively, despite recent suggestions to use log-binomial regression with a logarithmic link function to calculate the RII and with an identity link function to calculate the SII<sup>27,34</sup>. We encountered convergence issues when using log-binomial regression for some countries, which persisted even when resorting to robust Poisson regression as an alternative. We compared our results with those from log-binomial regression for countries where the latter model converged and found that results were similar

for RII and slightly higher for SII (when using logistic regression) but in the same direction. Fourth, no attempt to control for dental behaviours was carried out. As the aim was to assess the overall impact of SEP on oral health, it was deemed inappropriate to adjust for behaviours. Indeed, dental behaviours are considered as merely intermediates of the relationship between socioeconomic indicators and oral health<sup>1,35</sup>.

The existence of wealth inequalities in adult oral health favouring the poor contradicts the a-priori assumption that social gradients in oral health are universal<sup>1,2</sup>. Pro-poor inequalities in total tooth loss may be explained by differences in life expectancy between rich and poor. Tooth loss is age-dependent and will be more common among the rich if they live longer. A second explanation is that the poor may have less caries the main reason –the main reason for tooth loss– than the rich because sugar is still a commodity in some developing countries , and as such , only accessible to the better-off<sup>17</sup>. A final explanation combines high costs of treatment and delay in seeking care. Dental services in developing countries are mainly financed via out-of-pocket spending, driving individuals to seek dental care only when in trouble. Individuals may arrive to practice with more severe disease when tooth extraction might be the only possible care pathway. Under those circumstances, the poor could have more teeth (including tooth remnants) because they could not afford to have bad teeth extracted.

Wealth inequalities in perceived dental treatment needs favouring the poor were more common than those for total tooth loss. Indeed, more countries reported pro-poor than pro-rich inequalities in perceived needs. A possible explanation for these findings is that the priorities of the poor tend to diverge from those of the rich; the poor having more urgent needs in life to be met than those related to the condition of their mouth and teeth whereas the rich could identify better their oral health needs through enhanced access to information and health education<sup>16</sup>. This is in addition to evidence suggesting that people with the same state of health judge their quality of life differently according to their social standing<sup>36</sup>. It is also possible that adults with oral diseases, who are overrepresented in lower social groups, may have learned how to cope with frequent symptoms during the course of their condition, which in turn become less distressing with every recurrence, leading to changes in internal standards, values and beliefs (response shift)<sup>37</sup>.

This is the first study exploring social inequalities in adult oral health in low and middle income countries. Governments can use these baseline data to track their own progress relative to geographic neighbours, economic cousins, or a development reference group. The data could also inform policy

action to address oral health inequalities, although we need to understand country-specific conditions and tailor policies that take due consideration of these country-specific circumstances<sup>7,8</sup>. Since the WHS data is relatively old, future studies should evaluate whether the present findings are replicated when using alternative SEP indicators and clinical oral health indices.

In conclusion, this multi-country comparison provides evidence on the presence of social inequalities in adult oral health by household wealth in low and middle income countries, regardless of economic development. However, the well-documented social gradient in adult oral health favouring the rich was not observed in all low and middle income countries. Pro-poor inequalities in total tooth loss and particularly perceived dental treatment needs were seen in several countries.

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#### **COMPETING INTEREST**

The authors declare no competing interest.

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**Table 1.** Crude prevalence of total tooth loss among adults 18 years or older (n=179,763), by household wealth tertiles (World Health Survey, 2002-2004)

Group	Country	n <sup>a</sup>	All sample	Lowest tertile	Middle tertile	Highest tertile	P value for trend <sup>b</sup>
Low Income Countries (LIC)	Bangladesh	5411	1.2	0.8	1.6	1.2	0.489
	Burkina Faso	4694	1.6	1.8	1.5	1.3	0.291
	Chad	4128	5.1	7.5	4.7	3.2	0.001
	Ethiopia	4789	1.2	1.7	1.1	0.5	0.016
	Georgia	2718	12.9	17.0	13.2	9.2	<0.001
	Ghana	3448	1.6	1.6	1.7	1.6	0.994
	Kazakhstan	4460	10.7	11.7	9.8	10.7	0.759
	Kenya	4189	1.1	1.1	1.4	0.6	0.262
	Lao	4831	1.8	2.3	2.3	0.8	0.005
	Malawi	5117	2.5	2.3	3.1	2.1	0.798
	Mali	3379	1.9	1.7	2.2	2.0	0.708
	Myanmar	5886	1.1	1.6	0.9	1.0	0.278
	Nepal	8657	1.7	1.8	1.9	1.6	0.556
	Pakistan	5798	5.3	5.8	5.7	4.0	0.147
	Senegal	2295	5.4	4.8	6.8	4.8	0.907
	Vietnam	3261	2.1	1.5	1.4	3.2	0.018
	Zimbabwe	3644	15.1	22.1	11.7	8.6	<0.001
Lower Middle Income Countries (LMIC)	Bosnia & Herzegovina	1026	15.2	21.7	9.2	11.1	0.003
	Brazil	4960	14.7	18.4	15.8	11.0	<0.001
	Dominican Republic	4376	8.1	13.0	8.0	6.2	<0.001
	Ecuador	3876	8.1	8.0	10.1	6.2	0.162
	Morocco	4466	9.6	8.7	10.4	9.4	0.767
	Namibia	3675	15.5	13.3	12.5	21.3	0.003
	Paraguay	5079	4.7	4.4	6.1	3.6	0.125
	Philippines	10019	6.4	5.5	6.5	7.0	0.097
	South Africa	1992	8.8	9.3	6.9	10.4	0.783
	Sri Lanka	5372	4.2	6.8	4.0	3.4	0.117
	Swaziland	1905	7.7	12.8	7.2	3.2	<0.001
	Turkey	10828	13.6	16.3	15.1	9.8	<0.001
	Ukraine	2195	10.1	12.6	10.3	8.0	0.329
Upper Middle Income Countries (UMIC)	Croatia	967	11.6	21.0	7.8	9.3	0.003
	Czech Republic	875	11.4	22.6	8.2	2.6	<0.001
	Estonia	991	11.8	19.3	10.6	5.3	<0.001
	Hungary	1386	15.7	28.2	13.2	6.1	<0.001
	Latvia	839	10.3	17.9	9.7	1.7	<0.001
	Malaysia	5842	9.0	10.2	9.2	7.7	0.042
	Mauritius	3726	12.0	15.9	11.8	8.9	<0.001
	Mexico	24075	7.3	7.2	7.2	7.6	0.665
	Slovakia	1679	2.9	6.3	1.2	1.0	0.001
	Uruguay	2909	7.3	11.1	6.5	4.3	<0.001

<sup>a</sup> Counts are unweighted

<sup>b</sup> P value for trend derived from unadjusted survey logistic regression models

**Table 2.** Absolute and relative measures of inequalities in total tooth loss by household wealth in adults 18 years or older (World Health Survey, 2002-2004)

Group	Country	RII <sup>a</sup>	(95% CI)	SII <sup>a</sup>	(95% CI)
Low Income Countries (LIC)	Bangladesh	2.47	(0.99, 6.21)	1.0	(-0.1, 2.1)
	Burkina Faso	0.86	(0.31, 2.37)	-0.2	(-1.6, 1.2)
	Chad	0.40	(0.16, 1.01)	-4.0	(-8.3, 0.2)
	Ethiopia	0.21	(0.04, 1.08)	-1.7	(-3.2, -0.1)
	Georgia	0.82	(0.35, 1.93)	-1.7	(-8.5, 5.0)
	Ghana	1.38	(0.41, 4.65)	0.5	(-1.3, 2.3)
	Kazakhstan	2.36	(0.94, 5.96)	7.0	(-1.7, 15.7)
	Kenya	1.60	(0.34, 7.59)	0.4	(-1.0, 1.8)
	Lao	0.18	(0.07, 0.46)**	-2.9	(-4.5, -1.3)**
	Malawi	1.14	(0.48, 2.71)	0.4	(-1.7, 2.4)
	Mali	1.66	(0.53, 5.18)	1.0	(-1.2, 3.3)
	Myanmar	0.51	(0.15, 1.75)	-0.8	(-2.3, -0.6)
	Nepal	0.71	(0.34, 1.48)	-0.6	(-1.9, 0.7)
	Pakistan	0.67	(0.25, 1.80)	-1.5	(-5.8, 2.8)
	Senegal	1.05	(0.45, 2.45)	0.3	(-3.9, 4.5)
	Vietnam	7.08	(1.89, 26.46)**	3.8	(0.8, 6.8)*
	Zimbabwe	0.23	(0.14, 40.0)***	-16.8	(-22.7, -0.9)***
Lower Middle Income Countries (LMIC)	Bosnia & Herzegovina	0.31	(0.14, 0.70)**	-8.7	(-15.7, -1.7)*
	Brazil	0.65	(0.41, 1.04)	-3.6	(-8.1, 0.8)
	Dominican Republic	0.38	(0.18, 0.82)*	-6.0	(-10.4, -1.6)**
	Ecuador	0.50	(0.25, 1.00)	-4.5	(-9.1, 0.2)
	Morocco	1.11	(0.53, 2.32)	0.8	(-5.2, 6.7)
	Namibia	2.77	(1.58, 4.87)**	12.8	(5.6, 20.0)**
	Paraguay	0.94	(0.52, 1.72)	-0.4	(-3.1, 2.2)
	Philippines	1.82	(1.11, 2.98)*	3.5	(0.7, 6.3)*
	South Africa	1.92	(0.76, 4.87)	5.0	(-2.4, 12.3)
	Sri Lanka	0.61	(0.19, 1.92)	-1.8	(-5.4, 1.8)
	Swaziland	0.13	(0.05, 0.31)*	-13.5	(-19.4, -7.5)*
	Turkey	0.67	(0.46, 0.97)***	-4.0	(-7.5, -0.6)***
	Ukraine	1.42	(0.29, 6.88)	2.4	(-8.7, 13.5)
Upper Middle Income Countries (UMIC)	Croatia	2.08	(0.73, 5.94)	7.8	(-2.3, 17.9)
	Czech Republic	0.44	(0.09, 2.07)	-3.2	(-14.5, 8.0)
	Estonia	0.64	(0.24, 1.72)	-3.2	(-10.5, 4.1)
	Hungary	0.54	(0.24, 1.24)	-5.2	(-12.7, 2.2)
	Latvia	0.18	(0.05, 0.69)*	-9.7	(-18.8, -0.6)*
	Malaysia	0.81	(0.48, 1.37)	-1.7	(-5.1, 1.8)
	Mauritius	0.78	(0.50, 1.20)	-2.4	(-6.1, 1.4)
	Mexico	0.94	(0.65, 1.36)	-0.3	(-2.4, 1.9)
	Slovakia	2.66	(0.47, 14.96)	0.8	(-1.4, 3.0)
	Uruguay	0.29	(0.16, 0.53)***	-6.4	(-10.2, -2.7)**

<sup>a</sup> RII; Relative Index of Inequality; SII; Slope Index of Inequality

<sup>b</sup> Estimates were adjusted for participants' sex, age groups and education

\* p<0.05; \*\* p<0.01; \*\*\* p<0.001



**Table 3.** Crude prevalence of problems with mouth and/or teeth in adults 18 years or older (n=180,996), by household wealth tertiles (World health Survey, 2002-2004)

Group	Country	n <sup>a</sup>	All sample	Lowest tertile	Middle tertile	Highest tertile	P value for trend <sup>b</sup>
Low Income Countries (LIC)	Bangladesh	5425	42.6	43.7	42.5	41.8	0.365
	Burkina Faso	4697	24.9	24.3	25.9	24.4	0.756
	Chad	4157	29.3	33.1	29.4	25.4	0.001
	Ethiopia	4851	19.4	22.2	17.9	15.4	0.001
	Georgia	2709	49.4	47.0	51.0	50.4	0.447
	Ghana	3496	17.8	20.8	19.2	14.3	<0.001
	Kazakhstan	4469	63.7	63.0	64.1	64.0	0.741
	Kenya	4231	27.8	31.5	28.9	23.0	0.005
	Lao	4835	21.9	19.8	19.3	26.1	0.004
	Malawi	5146	37.3	41.6	38.1	31.6	<0.001
	Mali	3460	25.3	25.3	26.2	24.6	0.735
	Myanmar	5886	12.8	12.4	13.2	12.6	0.890
	Nepal	8623	34.0	36.6	35.1	31.2	<0.001
	Pakistan	5884	18.7	17.5	17.7	22.7	0.039
	Senegal	2332	29.9	34.0	25.8	28.5	0.180
	Vietnam	3366	21.0	21.1	19.8	21.6	0.868
	Zimbabwe	3686	33.6	32.7	33.2	34.9	0.387
Lower Middle Income Countries (LMIC)	Bosnia & Herzegovina	1020	33.9	33.1	34.9	34.2	0.831
	Brazil	4960	35.3	32.8	34.3	38.0	0.007
	Dominican Republic	4383	27.9	23.5	26.6	30.8	0.007
	Ecuador	3901	23.6	18.3	25.8	25.2	0.014
	Morocco	4467	43.4	39.6	43.3	46.3	0.040
	Namibia	3731	22.1	23.3	21.6	21.4	0.363
	Paraguay	5086	40.9	37.6	39.8	44.1	0.002
	Philippines	10029	38.0	41.7	38.5	34.4	<0.001
	South Africa	1964	17.1	17.7	18.1	15.2	0.510
	Sri Lanka	5685	22.0	19.2	21.3	23.9	0.168
	Swaziland	1918	21.6	22.5	17.5	24.0	0.669
	Turkey	11026	34.2	33.3	34.4	34.3	0.587
	Ukraine	2219	51.3	49.0	51.6	52.9	0.445
Upper Middle Income Countries (UMIC)	Croatia	968	40.0	33.7	40.9	42.9	0.060
	Czech Republic	876	46.3	47.1	42.7	49.6	0.719
	Estonia	991	52.8	51.0	53.5	53.8	0.507
	Hungary	1386	34.2	24.4	35.8	42.2	<0.001
	Latvia	842	47.5	42.7	50.8	49.8	0.178
	Malaysia	5845	20.5	19.8	18.5	22.9	0.041
	Mauritius	3733	23.8	21.7	26.3	23.1	0.503
	Mexico	24075	27.0	22.8	28.8	31.5	<0.001
	Slovakia	1728	41.3	35.8	42.2	46.3	0.111
	Uruguay	2910	27.8	20.4	27.1	35.8	<0.001

<sup>a</sup> Counts are unweighted

<sup>b</sup> P value for trend derived from unadjusted survey logistic regression models

**Table 4.** Absolute and relative measures of inequalities in problems with mouth and/or teeth by household wealth in adults 18 years or older (World Health Survey, 2002-2004)

Group	Country	RII <sup>a</sup>	(95% CI)	SII <sup>a</sup>	(95% CI)
Low Income Countries (LIC)	Bangladesh	0.90	(0.83, 1.53)	-2.4	(-4.6, 9.4)
	Burkina Faso	1.27	(0.95, 1.69)	4.2	(-0.9, 9.2)
	Chad	0.80	(0.54, 1.17)	-4.5	(-12.1, 3.1)
	Ethiopia	0.49	(0.30, 0.80)**	-10.4	(-17.4, -3.5)**
	Georgia	1.29	(0.79, 2.12)	6.3	(-5.8, 18.5)
	Ghana	0.59	(0.39, 0.90)*	-7.3	(-13.0, -1.6)*
	Kazakhstan	1.52	(1.01, 2.27)*	9.3	(0.1, 18.6)*
	Kenya	0.82	(0.51, 1.30)	-4.0	(-12.8, 4.9)
	Lao	1.61	(1.09, 2.38)*	8.0	(1.4, 14.6)*
	Malawi	0.62	(0.44, 0.87)**	-10.6	(-18.3, -3.0)**
	Mali	1.13	(0.76, 1.69)	2.2	(-5.0, 9.5)
	Myanmar	1.05	(0.70, 1.59)	0.6	(-4.0, 5.1)
	Nepal	0.71	(0.57, 0.87)**	-7.4	(-12.0, -2.9)**
	Pakistan	1.85	(1.13, 3.04)*	8.5	(1.4, 15.7)*
	Senegal	0.68	(0.34, 1.37)	-7.8	(-22.2, 6.5)
	Vietnam	1.27	(0.73, 2.20)	4.0	(-4.6, 12.6)
	Zimbabwe	0.76	(0.52, 1.11)	-5.7	(-13.6, 2.1)
Lower Middle Income Countries (LMIC)	Bosnia & Herzegovina	1.05	(0.47, 2.34)	1.0	(-16.7, 18.7)
	Brazil	1.13	(0.85, 1.49)	2.7	(-3.5, 8.8)
	Dominican Republic	1.83	(1.15, 2.89)**	11.9	(2.9, 20.9)**
	Ecuador	1.32	(0.88, 1.99)	4.9	(-2.2, 11.9)
	Morocco	1.39	(0.86, 2.23)	7.8	(-3.5, 19.2)
	Namibia	1.04	(0.68, 1.59)	0.5	(-6.5, 7.5)
	Paraguay	1.17	(0.87, 1.55)	3.6	(-3.2, 10.3)
	Philippines	0.69	(0.53, 0.88)**	-8.8	(-14.6, -3.0)**
	South Africa	0.73	(0.39, 1.35)	-4.1	(-12.5, 4.2)
	Sri Lanka	1.71	(0.80, 3.65)	9.1	(-4.5, 22.6)
	Swaziland	1.54	(0.73, 3.24)	7.3	(-5.2, 19.8)
	Turkey	1.07	(0.84, 1.35)	1.5	(-3.8, 6.7)
	Ukraine	1.11	(0.60, 2.07)	2.6	(-12.6, 17.7)
Upper Middle Income Countries (UMIC)	Croatia	1.47	(0.75, 2.89)	9.1	(-6.7, 25.0)
	Czech Republic	0.91	(0.40, 2.09)	-2.3	(-22.5, 18.0)
	Estonia	0.77	(0.40, 1.48)	-6.2	(-21.8, 9.4)
	Hungary	1.59	(0.93, 2.71)	10.0	(-1.5, 21.6)
	Latvia	0.92	(0.44, 1.93)	-2.0	(-19.9, 15.9)
	Malaysia	1.15	(0.84, 1.58)	2.1	(-2.7, 7.2)
	Mauritius	1.02	(0.75, 1.41)	0.4	(-5.3, 6.1)
	Mexico	1.83	(1.54, 2.16)***	11.7	(8.4, 15.1)***
	Slovakia	2.06	(0.91, 4.69)	16.7	(-2.2, 35.5)
	Uruguay	2.19	(1.26, 3.80)**	15.0	(4.2, 25.8)**

<sup>a</sup> RII; Relative Index of Inequality; SII; Slope Index of Inequality

<sup>b</sup> Estimates were adjusted for participants' sex, age groups and education

\* p<0.05; \*\* p<0.01; \*\*\* p<0.001